

APPLICATION OF PIEDMONT LANDSCAPE ECOSYSTEM CLASSIFICATION AS A REFERENCE FOR A VEGETATION AND HERPETOFAUNAL SURVEY ON LAKE THURMOND, SC

Victor B. Shelburne, Lawrence R. Gering, J. Drew Lanham,
Gregory P. Smith, Thomas M. Floyd, and Eran S. Kilpatrick¹

Abstract—Application of a Piedmont landscape ecosystem classification methodology was used as a basis for a survey of vegetation and herpetofaunal communities on a 343 hectare (846 acre) tract on Lake Thurmond near Plum Branch, SC. The site is located in the Carolina Slate Belt of the Midlands Plateau Region of the Piedmont province. A total of 160 plots were established and 30 were sampled intensively for vegetation. Herpetofaunal populations were sampled within 6 sites, representative of habitat types found throughout the site, using drift fences and pitfall traps.

Nearly 180 species of plants were documented and classification and ordination revealed the expected array of plant communities in an area that has not as yet achieved a steady state plant community. Landscape Ecosystem Classification revealed five site units in a repeating pattern across the site. Herpetofaunal communities were documented across the area by habitat type. Thirty species of herpetofauna were captured or otherwise recorded. This total included species from 2 classes (Amphibia, Reptilia), 4 orders (Caudata, Anura, Testudines, Squamata), and 2 suborders (Lacertilia, Serpentes). Species richness and abundance were greatest at depression wetlands (18), followed by riparian zones (16) and uplands (11). Depression wetlands and riparian zones should be given the highest priority in conserving critical habitats for herpetofauna on the training site.

Through the use of geographic information systems (GIS), a map showing the location of the various site types in relation to the vegetation and herpetofaunal communities was produced. These data may provide valuable reference information for the landowner.

INTRODUCTION

The South Carolina Army National Guard (SCARNG) and the Department of Forest Resources at Clemson University developed a cooperative research project to survey the vegetation and herpetofaunal resources at the SCARNG's Clarks Hill Training Site. The project included four phases or components: 1.) a vegetative communities survey, 2.) a flora survey, 3.) a herpetofaunal survey, and 4. the development of a geographical information system (GIS) for storing and displaying data associated with the three surveys.

The application of a Piedmont Landscape Ecosystem Classification methodology was used as a basis for determining forest communities and as a framework to survey the area's flora (Jones 1991). The methodology uses percent clay in the B horizon, depth to maximum clay, landform index, terrain shape index, and aspect as discriminators in classifying sites along a continuum from xeric to mesic.

The Piedmont is one of the most anthropogenically disturbed physiographic regions in the southeastern

United States. According to Godfrey (1997), forests regenerating on abandoned agricultural lands dominate the central Piedmont. As such, the area "...offers splendid laboratories in which to watch the advance of plant succession." (Godfrey 1997). Over 130 species of reptiles and amphibians have been recorded in South Carolina (Martof and others 1980, Zingmark 1978). Standardized methods were used to survey reptiles and amphibians inhabiting the training site and to assess the herpetofauna community composition and distribution in representative habitats across the site (Heyer and others 1994). For species of particular interest (high abundance, conservation concern, extralimital occurrence) notes on natural history and management implications are also included.

The results of the vegetative communities survey, flora survey, and herpetofaunal survey were incorporated into a GIS for data storage and display. These results were compiled into a series of themes or layers suitable for use by ArcView® and/or ArcInfo®.

¹Associate Professor, Assistant Professor, Assistant Professor, Graduate Residence Assistants, Department of Forest Resources, Clemson University, Clemson, SC., respectively.

OBJECTIVES

1. Describe the distribution and extent of plant alliances on the Clarks Hill Training Site.
2. Map the areal extent of ecological landtype phases using the Piedmont Landscape Ecosystem Classification (LEC) model.
3. Survey the site for vascular plants using verified nomenclature, classification and annotation.
4. Denote plots and flora listing with an associated map showing plot locations as determined by GPS.
5. Record species of reptiles and amphibians in representative habitats.
6. Render management recommendations regarding the conservation of herpetofauna communities.

METHODS

Study Site

The 343 hectare (846 acre) Clarks Hill Training Site tract is a peninsular landform bounded by Lake Thurmond (Clarks Hill Lake). The training site is located within the Carolina Slate Belt in the South Carolina Piedmont physiographic province (Myers and others 1986). Terrain in this region is typified by narrow floodplain bottomlands, streams and gently rolling uplands. Elevation ranges from 37 m to 214 m above mean sea level.

Most of the soils are Typic Hapludults with occasional Aquic Hapludults and Typic Dystrochrepts (Gay 1992, Smith and Haybeck 1979). Surface horizons are usually brown and loamy with an underlying argillic clay horizon. The growing season is approximately 215 days from late March to early November and the average rainfall of 120 cm is evenly distributed throughout the year (Gay 1992). The dominant forest cover type is a relatively homogeneous natural stand of 50-60 year old loblolly pine (*Pinus taeda*). Visual inspection of the site indicated historical disturbances (probably agricultural). Lotic water features within the training site include several "dry" branches (intermittent creeks) that flow into some of the lake's many coves. The only known lentic features within the site were 4 depression wetlands. These wetlands had a higher proportion of hardwood species than surrounding upland sites.

Methodology and Data Analyses: Ecosystem Classification A 20m x 20m plot was established in the fall of 1999 at each point using the methodology as described in the North Carolina Vegetation Survey (NCVS) (Peet and others 1998). Plots were usually located in the geometric center of the stand but were occasionally adjusted to insure homogeneous species composition and uniform stand structure within the plot. The tree stratum (dbh > 11.4 cm) was sampled by species and diameter within the 0.10 ha plot, and the sapling and shrub stratum (>1.4 m tall, less than 11.4 cm dbh) was sampled by species and diameter class as indicated by the survey methodology. Tree seedlings, low shrubs, herbaceous species, and rhizomatous shrubs were tallied by species and in frequency classes in the whole plot.

Landform and soil variables were also examined at each plot. Landform index was derived from the mean of eight

measurements in percent scale taken with a clinometer at forty-five degree spacings from plot center to the surrounding horizons. Terrain shape index (TSI) was determined at each plot to determine microsite convexity or concavity. Soil samples were systematically collected from three locations within the plot using an auger. Using averages from the three collection sites, depth of A and E horizons, epipedon thickness, and soil solium depth were determined. Vegetation data are summarized by species for each intensive plot. Cover classes for all species (trees, shrubs, herbs, vines, and seedlings) are noted for each plot. Plots are then referenced on maps within a GIS (phase 4 of this project).

Presence is defined as the occurrence of a species (based on emergence of a stem or stems) within an area of a given size and location. Presence is a vegetation parameter compatible across all plant growth forms that can be used for many analytical procedures (ordination and classification). Presence/absence data taken from the nested plots in the NCVS provide fundamental data for characterization of community composition and structure (Peet and others 1998).

Cover is defined as the percentage of ground surface obscured by the vertical projection of all aboveground parts of a given species onto that surface. Percentage cover provides an index of a species' potential contribution to community production. In the NCVS protocol, cover is the only quantitative vegetative parameter compatible across all plant growth forms. Percent cover was estimated visually by the researcher during this study. The cover classes and percentage cover ranges that used in this study were: 1 = trace, 2 = 0-1 percent, 3 = 1-2 percent, 4 = 2-5 percent, 5 = 5-10 percent, 6 = 10-25 percent, 7 = 25-50 percent, 8 = 50-75 percent, 9 = 75-95 percent, 10 > 95 percent (Peet and others 1998).

A series of multivariate techniques was used for analysis of data. Detrended Correspondence Analysis (DCA) (DECORANA, Hill 1979a), which ordinales species and samples simultaneously, was the method of ordination used to analyze vegetation data (McCune and Mefford 1999). DCA or DECORANA" was used to analyze species abundance by organizing and displaying data in multidimensional space (Hill 1979a).

Cluster analysis of vegetation was performed by Two Way Indicator Species Analysis (TWINSpan, Hill 1979b). TWINSpan" is a polythetic diverse classification that simultaneously classifies both species and plots using the main matrix for vegetation data (McCune and Mefford 1999). This is a subjective classification, and allows the investigator to draw a separation between the groups in the initial ordination of plots (Hutto and others 1999). TWINSpan was used in conjunction with DCA to reduce this subjectivity while delineating groups of similar plots. TWINSpan was also used to identify indicator or diagnostic species that were strongly correlated to a certain community association.

A landscape ecological classification model developed by Jones (1988, 1991) was employed. This model uses depth

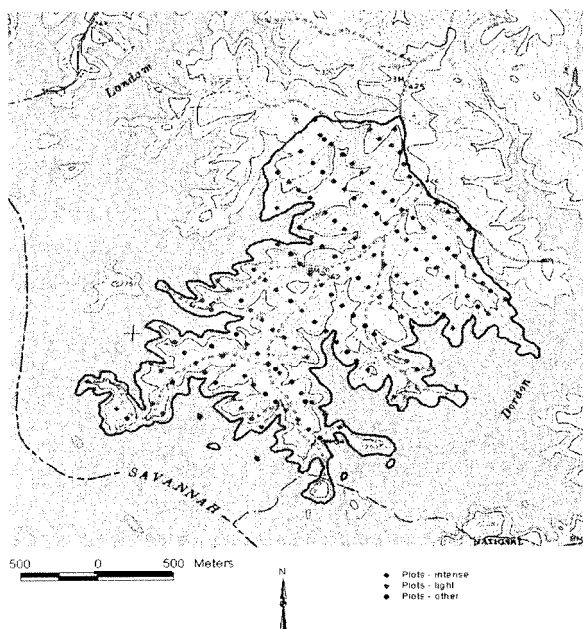


Figure 1-Location of 160 plots on the South Carolina Army National Guard training site on Lake Thurmond in South Carolina.

to maximum clay, percent clay, aspect, landform index and terrain shape index. The actual basis for using this model is based on the conclusion by Gay (1992) that the Jones model for the Interior Uplands Plateau in the Piedmont was compatible with the Slate Belt Subregion in the Piedmont. Transects were established throughout the site at an approximate sampling ratio of one survey plot for every five acres. Transect lines were spaced 201.2 meters (10 chains) apart and plot centers were located at intervals of 100.6 meters (5 chains) along the transect lines. Global positioning system (GPS) technology was used to record the location of the plot centers. On each of the 160 plots, data on Landform Index, aspect, soils and presence/frequency of overstory species were collected. Every fifth plot of this systematic sample was designed to be an "intensive plot" where additional data on the understory flora were collected. This process resulted in 30 intensively surveyed plots and 130 lightly surveyed plots (figure 1). All data were compiled by cover type and landtype phase (mesic, sub-mesic, intermediate, sub-xeric and xeric) by plot in both tabular and map formats.

Herpetofaunal Sampling

Six study sites, representative of the habitat types of the surrounding landscape, were established for herpetofaunal sampling. These sites included 2 depression wetland sites, 2 riparian sites along creeks, and 2 upland sites. Trapping methods included drift fences with pitfalls and cover-boards. Drift fences were 10m long x 0.6m high silt cloth with 2 pitfall traps (each a 5 gallon bucket, buried flush with the soil surface) at each end of the fence for a total of 4 pitfalls/fence. A total of 24 fences (4/site) and 96 pitfalls (1 G/site) were installed among depression wetland, riparian, and upland sites. A total of 24 coverboards (0.6m x 1.2m, plywood and tin) were installed

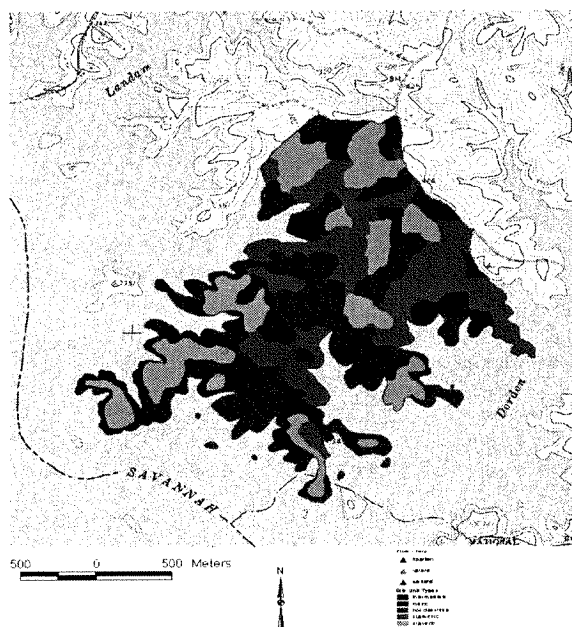


Figure 2-Five site units, determined by Landscape Ecosystem Classification, South Carolina Army National Guard training site on Lake Thurmond in South Carolina.

within two of the study sites (12 within a riparian site and 12 within a depression wetland site). During monitoring sessions, aural surveys were conducted to record the presence of frog (Anuran) species. Area/time constrained searches to record species or individuals that may not have been captured in traps, were also conducted. Individuals that were captured were identified to species and sex (when possible), and released on the opposite side of the drift fence from which they were captured.

RESULTS AND DISCUSSION

Ordination and Cluster Analysis

Ordination arranged the intensive plots along two axes that together represented a possible soil moisture gradient. Based on ordination and cluster analysis (classification), the plots were separated into three groups. An evaluation of the classification analysis for all plots indicated that there were many plant species which were not preferential; in other words, many species were not found in greater abundance in one group over another. This pattern fits the expectation for the earlier stages of succession which these plots mostly represent.

Community and Floral Survey

Most of the tract is dominated by 50 • 60 year old loblolly and shortleaf pine. Five site units were mapped on the site (figure 2): Xeric (3.6 hectares: 1 percent of the area); Sub-xeric (77 hectares: 23 percent); Intermediate (156 hectares: 46 percent); Sub-mesic (89 hectares: 26 percent); Mesic (15 hectares: 4.5 percent); 180 plant species were described on the 30 intensive plots.

A description of these site units is as follows. 1.) Xeric sites are the driest, most exposed sites. They are the most

unproductive sites since either a combination of high clay content close to the soil surface or the location of the site (i.e., exposed ridges which do not retain moisture) makes for poor growing conditions for most species. Loblolly pine site index (index age 50) is generally 60 feet on these xeric sites. 2.) Sub-xeric sites exhibit slightly higher productivity either through a combination of lower clay content, greater depth to maximum clay or less exposure. This is a fairly common site type throughout the South Carolina Piedmont. Site index for loblolly pine in these sub-xeric sites is approximately 70 feet. 3.) The intermediate site unit is also fairly common and makes up the plurality of sites on this tract. Clay is usually not as close to the soil surface or there is some combination of aspect and exposure which provides a greater degree of site protection creating higher moisture retention in the soil. Site index for loblolly pine in these intermediate sites is approximately 80 feet. 4.) Sub-mesic site units usually exhibit a much reduced clay content that is at least 12 inches or more from the soil surface. Likewise, landform indices are generally high, reducing exposure to the drying effects of the sun. These sites generally occur on lower and north facing slopes where there is greater moisture retention due to runoff from upper slopes and more protection. Site index for loblolly pine in these sub-mesic sites is approximately 90 feet. 5.) Finally, mesic sites exhibit a combination of low clay content, high landform indices and north facing slopes. However, not all three factors must be present for a mesic site to occur. These sites also occur along stream bottoms and cove sites. They exhibit the greatest degree of moisture retention because of their place on the landscape. Site index for loblolly pine in these mesic sites can exceed 100 feet.

The determination of site unit scores and the actual location of site units is subject to some error. At best, there is a 20 percent chance that any particular point will be either a site unit higher or lower than is actually determined. This is due to microsite variations not picked up in the sampling scheme. Also, there is some inherent error in the model itself. Therefore, these data and mapping units are most suitable for planning purposes in terms of overall site productivity of an area.

Herpetofaunal Survey

Thirty species of herpetofauna were captured or otherwise recorded as occurring on the training site from May 12, 2000 through January 27, 2001. This total included species from 2 classes (Amphibia, Reptilia), 4 orders (Caudata, Anura, Testudines, Squamata) and 2 suborders (Lacertilia, Serpentes). Species richness and abundance were greatest at depression wetlands (18), followed by riparian zones (16) and uplands (11). Ambystomatid salamanders (mole salamanders) were the most frequently captured taxa among all sites with most captures occurring in depression wetlands.

The overall herpetofauna richness (represented as the number of species), showed a relatively uniform distribution by taxa. The taxon with the fewest species was Testudines (four turtle species), and the taxon with the greatest number of species was Serpentes (nine snake

species). The overall herpetofauna abundance (represented by the number of individuals captured or observed) shows an unequal distribution by taxa. There were relatively few individuals in the order Testudines and suborder Serpentes and a moderate number in the order Anura (frogs) and suborder Lacertilia (lizards). The order Caudata had the greatest number (476) of individuals captured or observed.

The depression wetlands habitat type had the greatest number of individual amphibian captures (542) while the riparian and uplands habitat types had fewer individual amphibian captures (33 and 16, respectively). However, the number of individual reptiles was fairly uniform across all three habitat types. Separating the two classes into orders and suborders shows that the greatest number of individuals captured was salamanders in wetland depression sites (456 individual captures). Though of lesser numbers, the dominant taxa in the riparian habitats were salamanders and frogs. Lizards were the dominant taxa in the upland habitat (22 individual captures).

CONCLUSIONS AND RECOMMENDATIONS

The Piedmont Landscape Ecosystem Classification methodology provided a working framework for classifying sites on the tract. Although classification of the sites provided a framework for a floral survey, ordination and classification of the vegetation did not distinguish between the five site units due to the mid-successional status of the landscape. Depression wetlands and riparian zones should be given the highest priority in conserving critical habitats for herpetofauna. This should include reserving appropriate buffers around depressions and along streams.

Species most sensitive to disturbance are likely to be Ambystomatid salamanders (mole salamanders). These species rely on ephemeral wetlands for breeding habitats. The occurrence of *Ambystoma talpoideum* (mole salamander) at the training site is noteworthy since it is believed to occur mostly as a Coastal Plain species in South Carolina. Surrounding uplands are important as buffers but also as non-breeding habitats for many species. The four-toed salamander (*Hemidactylium scutatum*), a disjunctly distributed species, occurs on the training site in riparian areas and areas adjacent to wetland depressions. By nature of its limited distribution in South Carolina, its status and conservation should also be a priority.

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